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ADJUSTMENT OF EVALUATED MICROSCOPIC DATA ON THE BASIS OF EVALUATED INTEGRAL EXPERIMENTS

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ABSTRACT

A new set of 78 integral experiments is described and used for the adjustment of constants. The adjustments are not very great in relation to the optimized system of constants for OSCAR-75 atomic reactors, which was described two years ago.

At the conference held two years ago, the method of obtaining an optimized system of constants for OSCAR-75 atomic reactors was described [1], [2], [3]. Paper [2] gives group constants obtained from evaluated microscopic nuclear data. Paper [3] gives the adjustments of these group constants as obtained in the light of the best description of a set of 48 integral experiments. Thus, the system of constants under reference was determined by papers [2] and [3].

On the basis of OSCAR-75, calculations were made for the standard Baker reactor [4], and a significant reduction of the breeding ratio was noted, from 1.36 in BNAB-70 to 1.23 ± 0.03.

Information on a large number of new integral experiments, carried out both in the USSR and in other countries, has by now appeared. These experiments were carried out in such a way that the corrections necessary to establish the adequacy of the experiment and the calculational model are not very great, and can thus be introduced without substantial error. Once the corrections were made, these experiments provided the library of evaluated integral experiments at the Nuclear Data Centre with a great deal of fresh data: it now comprises the results of 78 experiments, only 30 of which were used previously in obtaining constants for OSCAR-75. A full list of the experiments held, for which the sensitivity coefficients have also been calculated, is presented in Table 1.

The methods of correction or evaluation of the integral experiments have been checked both by calculation and experiment, and the authors are confident of their reliability. The error in the corrections can be assumed to be ~ $^1/_3$ of the correction introduced. Table 2 shows, as an example, correction values in a number of critical assemblies (column 1) for the relative reactivity coefficients (column 2). Column 3 shows the experimental value [5], [6], for samples with zero thickness; column 4 shows its calculated value for a homogeneous medium in a P_I approximation according to programme M26 [7] with the constants of BNAB-70 [8]; column 5, the same value but taking into account the unblocking of the medium; column 6, the same value taking into account the heterogeneous structure of the critical assembly [10], [9]; and column 7, again the same value but taking into account the finite width of the group [11].

The results of the calculations, with the corrections made (column 7), correspond to a calculational model of adequate practical experimental procedure (column 3).

The constants were optimized by carrying out several sets of integral experiments. The adjustments were calculated from OSCAR-75. By using firstly only Soviet experiments, and then only those originating in other countries, we obtained the same adjustments as with the full set. This demonstrates the good mutual agreement of these experiments. When the set of experiments is divided up according to a methodological principle, certain differences appear. Thus in Table 3, column 1, we have the adjustments for the full set of experiments, in column 2 for the set without the cross-sections relations, and in column 3 for the set without the reactivities and coefficients. Column 4 shows the adjustments for the values of FIS and CAP for ^{235}U, ^{239}Pu and ^{238}U in relation to the group constants [2] obtained from the simultaneous evaluation of Sowerby et al. The last line of the table shows values for the change in the breeding ratio for the reactor simulator OK-5 compared with OSCAR-75. This change is less than the error described for the breeding ratio in OSCAR-75 as equal to ± 0.03.

A new OSCAR system on the lines of Bondarenko group constants will be designed on the basis of all the latest evaluations of microscopic nuclear data, using the 78 integral experiments described.

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Table I

BFS-25	F8/F5, F9/F5, P9/P5
BFS-26	F8/F5, F9/F5, P9/P5, PB/P9, PC/P9
BFS-27	F8/F5, F9/F5, P9/P5, PB/P9, PC/P9
BFS-28	F8/F5, F9/F5, C8/F5, PB/P9, P9/P5, PC/P5
BFS-30	F8/F5, F9/F5, C8/F5, P9/P5, PB/P5,
BFS-31	K, F9/F5, F8/F9, C8/F9, P9/P5, PB/P5, PC/P5
BFS-33	K, F9/F5, F8/F9, C8/F9, P9/P5, PB/P5,PC/P5
ZPR-6-6A	K, F8/F5, C8/F5, P9/P5, P8/P5, PB/P5
ZPR-6-7	K, F9/F5, F8/F9, C8/F9, P9/P5, P8/P5, PB/P5, PN/P5, PC/P5
ZPR-3-48	F8/F5, F9/F5, C8/F5, FO/F5
ZEBRA-3	K, F9/F5, F8/F9, FO/F9, P9/P5, P8/P5
SNEAK-7A	K, F9/F5, F8/F9, C8/F9, P9/P5, P8/P5, PB/P5
SNEAK-7B	F9/F5, K, F8/F9, C8/F9, P9/P5, P8/P5, PB/P5

Table II

1	2	3	4	5	6	7
BFS-33-I	PB/P5	-0,96±0,03	-0,715	-0,715	-0,716	-0,715
	P9/P5	1,250±0,015	1,205	1,205	1,204	1,210
	PC/P5	-0,0057±0,0005	-0,0082	-0,0087	-0,0087	-0,0092
ZPR-YI-7	PB/P5	-0,945±0,045	-0,801	-0,801	-0,890	0,886±0,029
	P9/P5	1,21±0,02	1,18	1,18	1,17	1,17
	P12/P5	-0,0047±0,0002	-0,0083	-0,0087	-0,0074	-0,0077 ±0,0002

Table III

	1	2	3	4
CAP Pu-239, E1	-1,3	-2,5	1,2	-0,6
CAP Pu-239, E2	0,4	-0,25	0,7	-0,1
CAP Pu-239, E3	-4,6	-2,9	2	4,0
FIS Pu-239, E1	-5,4	-7	0,4	-0,9
FIS Pu-239, E2	-2,9	-3,5	-0,9	-3,0
FIS Pu-239, E3	0,8	1,1	1,7	5,1
NUF Pu-239, E1	-0,4	-0,4	0	-
NUF Pu-239, E2	-0,11	-0,2	0	-
NUF Pu-239, E3	0	0,1	0	-
CAP U-235, E1	-1,7	-2,5	1	35
CAP U-235, E2	-5	-2,3	-1	15
CAP U-235, E3	-3,7	0,6	0	-7,4
FIS U-235, E1	-3	-3	3	-7
FIS U-235, E2	-2,3	-1,5	0,1	-5
FIS U-235, E3	-2,1	-0,6	0	-3,6
NUF U-235, E1	0	-0,1	0	-
NUF U-235, E2	0	-0,07	0	-
NUF U-235, E3	0,1	-0,15	0	-
CAP U-238, E1	-1,5	-3	1,4	-9,4
CAP U-238, E2	-4	-7	1,1	-13,7
CAP U-238, E3	-4	-6,2	-0,3	-11
FIS U-238, E1	0	-1,8	1,2	8,5
NUF U-238, E1	0,8	0	-0,1	-
BR OK-5	-0,5	-2	-1	

E1- $0,8 < E < 10,5$; E2- $0,1 < E < 0,8$; E3 $E < 0,1$ MeV